THE AQUATIC PLANT COMMUNITY IN MCGINNIS LAKE, ADAMS COUNTY, WISCONSIN

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ADAMS COUNTY 2006

I. INTRODUCTION

An aquatic macrophyte (plant) field study of McGinnis Lake was conducted during June 2006 by a staff member of the Wisconsin Department of Natural Resources and a staff member of the Adams County Land and Water Conservatism Department.

Information about the diversity, density and distribution of aquatic plants is an essential component in understanding the lake ecosystem due to the integral ecological role of aquatic vegetation in the lake and the ability of vegetation to impact water quality (Dennison et al, 1993). This study will provide information useful for effective management of McGinnis Lake, including fish habitat improvement, protection of sensitive areas, aquatic plant management, and water resource regulation. This baseline data will provide information that can be used for comparison to future information and offer insight into changes in the lake.

Ecological Role: Lake plant life is the beginning of the lake's food chain, the foundation for all other lake life. Aquatic plants and algae provide food and oxygen for fish and wildlife, as well as cover and food for the invertebrates that many aquatic organisms depend on. Plants provide habitat and protective cover for aquatic animals. They also improve water quality, protect shorelines and lake bottoms, add to the aesthetic quality of the lake, and impact recreation.

Characterization of Water Quality: Aquatic plants can serve as indicators of water quality because of their sensitivity to water quality parameters such as clarity and nutrient levels (Dennison et al, 1993).

McGinnis Lake readings for hardness consistently score its water as “hard”, with the pH running between 6.0 and 8.25. Such hard water lakes tend to produce more fish and aquatic plants than soft water lakes.

Background and History: McGinnis Lake is located in the Town of New Chester, Adams County, Wisconsin. The impoundment is 33 surface acres in size. Maximum depth is 28’, with an average depth of 9’. During the summer of 2006 when this aquatic plant survey was conducted, the lake was at slightly lower level than usual due to drought and very hot weather. The dam is owned by Adams County and supervised by the Adams County Land & Water Conservatism Department. There is a public boat ramp located on east end of the lake owned by The Adams County Parks Department.

McGinnis Lake is easily accessible off of County Highway G. Residential development around the lake is found along most of the lakeshore. The surface watershed is small and heavily residential (78.18%). Remaining land uses in the surface water include non-irrigated agriculture (1.95%), woodlands (15.84%) and water (4.23%). The ground watershed contains 4.94% non-irrigated agriculture, 7.7% irrigated agriculture, 67.07% woodlands, 14.77% residential, 3.35% open grassland, and 2.17% water. There are endangered or threatened terrestrial resources at the far east end of the surface watershed, but no known endangered or threatened species in or directly around the lake. In the past, the deep lobe of the lake was mined for marl for agricultural use. There are no known archeological or historical sites in either watershed.

Fish stocking records go back to 1969 when brook and rainbow trout were stocked in the lake, as well as bluegills and largemouth bass. Stocking records through 1992 show continued input of bass, bluegills, and northern pike. Fish inventory records go back to 1963, when large mouth bass and bluegills were abundant; shiners, minnows and sunfish were common; perch and sucker were scarce. A 1980 inventory after a history of low oxygen and water quality problems recommended installation of an aeration system (the system has been installed). At that time, bluegills, pumpkinseed, black crappies, large mouth bass, black bullheads, northern pike and white suckers were found. A 1980 inventory noted stunted bluegills in abundance, with largemouth bass and pumpkinseed present. That inventory recommended a lake drawdown and panfish removal, also noting very thick watermilfoil and historic heavy algal blooms.

Soils directly around McGinnis Lake tend to be sands of various slopes, including some very steep slopes up to 20% on the north side of the lake. The farther the soil is from the lake, the more likely it is that there will be loamy sands mixed with sands. Such soils tend to be excessively-drained, with infiltration of water being rapid to very rapid, and permeability also high. Such soils also usually have a low water-holding and low organic matter content, thus making them difficult to establish vegetation on. These soils tend to be easily eroded by both water and wind.

Efforts at controlling aquatic plant growth have been exclusively chemical. The first recorded chemical applications were in 1979, but specific chemicals, amount applied and acreage cover are not available in the records. No information is yet available for 2006.

Year	Aquathol	Diquat	Cutrine	Reward	K-Tea	CuSO4
	(gal) or (lbs)	(gal)	(gal) or (lbs)	(gal)	(gal)	(lbs)
1986		8 gal	10 lbs			
1987		6 gal	30 lbs			
1988		6 gal	20 lbs			
1991	5 gal	5 gal	5 gal			
1992	5 gal	5 gal	5 gal			
1993	4 gal	8 gal	8 gal			
1994	240 lbs		120 lbs			
1995	3 gal	5 gal	5 gal			
1996	5 gal	5 gal	5 gal			
1997	11 gal			5.5 gal		25 gal
1998	5 gal		54 gal	3 gal		
1999	10 gal			5 gal	7.5 gal	
2000	8 gal		17.9 gal	4.5 gal		
2001	10.5 gal		25.66 gal	8.6 gal		
2003	27 gal		8.98 gal			
2004	27 gal		13.5 gal			
2005	60 gal					
total	**180.5 gal**	**48 gal**	**148.04 gal**	**26.6 gal**	**7.5 gal**	**25 gal**
	249 lbs		**180 lbs**			

Cutrine and CuSO4 are copper products that were used to kill algae and reduce swimmer's itch (Table 2). . Since copper is an element, it does not biodegrade further, building up the sediments. The drawbacks of copper treatments are:

a) the very short effective time
b) the toxicity of copper to aquatic insects, an important part of the food chain in a lake
c) the build up of copper in the sediments, resulting in sediments that are toxic to mollusks that are the natural consumers of algae in a lake.

The first recorded aquatic plant survey was by DNR staff in 1963. This qualitative survey showed that the plant-like algae, *Chara spp*, abundant, as was

Ceratophyllum demersum (coontail). Water milfoil was also abundant; smartweed was common. Pondweeds were scarce, as was filamentous algae. A limited survey was done by UWSP students for *Potamogeton crispus* (Curly-Leaf Pondweed) in 2002. In 2004, a sensitive area study was done on McGinnis Lake. Aquatic vegetation found included *Ascelpias incarnata, Calamagrostis canadensis, Ceratophyllum demersum, Chara spp, Cicuta bulbifera, Iris versicolor, Myriophyllum sibiricum, Najas flexilis, Potamogeton crispus, Potamogeton illinoensis, Potamogeton pectinatus, Potamogeton richardsonii, Ranunculus longirostris, Rumex spp, Salix spp, Scirpus validus* and *Typha latifolia.* Substantial filamentous algae were also noted.

II. METHODS

Field Methods

The study was based on the rake-sampling method developed by Jessen and Lound (1962), using stratified random transects. The shoreline was divided into 19 equal sections, with one transect placed randomly within each segment, perpendicular to the shoreline.

One sampling site was randomly chosen in each depth zone (0-1.5'; 1.5'-5'; 5'-10'; 10'-20') along each transect. Using long-handled, steel thatching rakes, four rake samples were taken at each site. Samples were taken from each quarter around the boat. Aquatic species present on each rake were recorded and given a density rating of 0-5.

A rating of 1 indicates the species was present on 1 rake sample.

A rating of 2 indicates the species was present on 2 rake samples.

A rating of 3 indicates the species was present on 3 rake samples.

A rating of 4 indicates the species was present on 4 rake samples.

A rating of 5 indicates that the species was abundantly present on all rake samples.

A visual inspection and periodic samples were taken between transects to record the presence of any species that didn't occur at the raking sites. Gleason and Cronquist (1991) nomenclature was used in recording plants found.

Shoreline type was also recorded at each transect. Visual inspection was made of 50' to the right and left of the boat along the shoreline, 35' back from the shore (so total view was 100' x 35'). Percent of land use within this rectangle was visually estimated and recorded.

Data Analysis:

The percent frequency (number of sampling sites at which it occurred/total number of sampling sites) of each species was calculated. Relative frequency (number of species occurrences/total all species occurrences) was also figured. The mean density (sum of species' density rating/number of sampling sites) was calculated for each species. Relative density (sum of species' density/total plant density) was also figured. Mean density where present (sum of species' density rating/number of sampling sites at which species occurred) was calculated. Relative frequency and relative density results were summed to obtain a dominance value. Species diversity was measured by Simpson's Diversity Index.

The Average Coefficient of Conservatism and Floristic Quality Index were calculated as outlined by Nichols (1998) to measure plant community disturbance. A coefficient of Conservatism is an assigned value between 0 and 10 that measures the probability that the species will occur in an undisturbed habitat. The Average Coefficient of Conservatismism is the mean of the coefficients for the species found in the lake. The coefficient of conservatism is used to calculate the Floristic Quality Index, a measure of a plant community's closeness to an undisturbed condition.

An Aquatic Macrophyte Community Index was determined using the method developed by Nichols et al (2000). This measurement looks at the following seven parameters and assigns each of them a number on a scale of 1-10: maximum depth of plant growth; percentage of littoral zone vegetated; Simpson's diversity index; relative frequency of submersed species; relative frequency of sensitive species; taxa number; and relative frequency of exotic species. The average total for the North Central Hardwoods lakes and impoundments is between 48 and 57.

III. <u>RESULTS</u>

Physical Data

The aquatic plant community can be impacted by several physical parameters. Water quality, including nutrients, algae and clarity, influence the plant community; the plant community in turn can modify these boundaries. Lake morphology, sediment composition and shoreline use also affect the plant community.

The trophic state of a lake is a classification of water quality (see Table 1). Phosphorus concentration, chlorophyll a concentration and water clarity data are collected and combined to determine a trophic state. **Eutrophic lakes** are very productive, with high nutrient levels and large biomass presence. **Oligotrophic**

lakes are those low in nutrients with limited plant growth and small populations of fish. **Mesotrophic lakes** are those in between, i.e., those which have increased production over oligotrophic lakes, but less than eutrophic lakes; those with more biomass than oligotrophic lakes, but less than eutrophic lakes; those with a good and more varied fishery than either the eutrophic or oligotrophic lakes.

The limiting factor in most Wisconsin lakes, including McGinnis Lake, is phosphorus. Measuring the phosphorus in a lake system thus provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth. **The 2004-2006 summer average phosphorus concentration in McGinnis Lake was 54.82 ug/l.** This is below the average for impoundments. This concentration suggests that McGinnis Lake is likely to have nuisance algal blooms, but not as frequently as many impoundments. This places McGinnis Lake in the "fair" to "poor" water quality section for impoundments, but in the "**eutrophic**" level for phosphorus. It should also be noted that the average total phosphorus reading at the deep hole in McGinnis Lake is more than twice as much as the average total phosphorus reading for the surface, suggesting that phosphorus is accumulating in the lake.

Chlorophyll concentrations provide a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth. **The 2004-2006 summer average chlorophyll concentration in McGinnis Lake was 3.19 ug/l.** The low chlorophyll concentration results places McGinnis Lake at the "oligotrophic" level for chlorophyll a results.

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity can be reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color or cloud the water. Water clarity is measured with a Secchi disk. **Average summer Secchi disk clarity in McGinnis Lake in 2004-2006 was 6.12'.** This is good water clarity, putting McGinnis Lake into the "mesotrophic" category for water clarity.

It is normal for all of these values to fluctuate during a growing season. They can be affected by human use of the lake, by summer temperature variations, by algae growth & turbidity, and by rain or wind events. Phosphorus tends to rise in early summer, than decline as late summer and fall progress. Chlorophyll a tends to rise in level as the water warms, then decline as autumn cools the water. Water clarity also tends to decrease as summer progresses, probably due to algae growth, then decline as fall approaches.

Table 1: Trophic States

Trophic State	Quality Index	Phosphorus (ug/l)	Chlorophyll a (ug/l)	Sechhi Disk (ft)
Oligotrophic	Excellent	<1	<1	>19
	Very Good	1 to 10	**1 to 5**	8 to 19
Mesotrophic	Good	10 to 30	5 to 10	**6 to 8**
	Fair	30 to 50	10 to 15	5 to 6
Eutrophic	Poor	**50 to 150**	15 to 30	3 to 4
McGinnis Lake		**54.82**	**3.19**	**6.12**

According to these results, McGinnis Lake scores as **"eutrophic"** in its phosphorus level, "**oligotrophi**c" in chlorophyll a readings, and "**mesotrophic"** in

Secchi disk readings. With such phosphorus readings, dense plant growth would be expected, but not frequent algal blooms.

Lake morphology is an important factor in distribution of lake plants. Duarte & Kalff (1986) determined that the slope of a littoral zone could explain 72% of the observed variability in the growth of submerged plants. Gentle slopes support higher plant growth than steep slopes (Engel 1985).

McGinnis Lake is a two-lobed lake, with one basin being much deeper than the other. Much of the lake is shallow. With good water clarity and shallow depths, plant growth may be favored in McGinnis Lake, especially in the shallower lobe, since the sun can get to most of the sediment to stimulate plant growth.

Sediment composition can also affect plant growth, especially those rooted. The richness or sterility and texture of the sediment will determine the type and abundance of macrophyte species that can survive in a particular lake (see Table 2).

Table 2: Sediment Composition—McGinnis Lake

		OVERALL	ZONE 1	ZONE 2	ZONE 3	ZONE 4
HARD	SAND	9.8%	20.0%			28.6%
	SAND/ROCK	2.0%	6.7%			
MIXED	SAND/MARL	3.9%	6.7%	6.7%		
	SAND/PEAT	2.0%				14.2%
	SAND/SILT	5.9%	20.0%			
	SILT/ROCK	5.8%	20.0%			
SOFT	MUCK	9.8%	20.0%	13.3%		
	MUCK/MARL	3.9%		13.3%		
	PEAT	9.8%			14.3%	42.9%
	PEAT/MARL	2.0%			7.1%	
	SILT	2.0%		6.7%		
	SILT/MARL	13.7%	6.6%	33.3%	7.1%	
	SILT/PEAT	2.0%			7.1%	

Over 43% of the sediment in McGinnis Lake is soft with natural fertility and significant available water holding capacity. Although sand sediment may limit growth in some instances, all sandy sites in McGinnis Lake were vegetated. In fact, 100% of the sample sites were vegetated in McGinnis Lake, no matter what the sediment.

Shoreline land use often strongly impacts the aquatic plant community and thus the entire aquatic community. Impacts can be caused by increased erosion and sedimentation and higher run-off of nutrients, fertilizers and toxins applied to the land. Such impacts occur in both rural and residential settings.

Traditional cultivated lawn was the shoreline cover with highest percent cover (36.67%). Other disturbed sites, such as those with rock/riprap and hard structures (such as piers) covered another 9% of the shoreline.

Table 3: Shoreland Land Use—McGinnisLake

	Type	Frequency	Coverage
Vegetated	Herbaceous	100.00%	30.67%
Shoreline	Shrub	46.67%	15.67%
	Wooded	40.00%	8.00%
Disturbed	Cultivated Lawn	60.00%	36.67%
Shoreline	Hard Structure	33.33%	3.67%
	Riprap	20.00%	5.32%

Some type of native vegetated shoreline was found at 100.00% of the sites and covered 54.34% of the lake shoreline.

Macrophyte Data

SPECIES PRESENT

Of the 39 species found in McGinnis Lake in 2006, 37 were native and 2 were exotic invasives. In the native plant category, 23 were emergent, 3 were free-floating plants, 1 was a floating-leaf rooted type, and 10 were submergent types (see Table 4). Two exotic invasives, *Phalaris arundinacea* (Reed Canarygrass) and *Potamogeton crispus* (Curly-Leaf Pondweed), were found.

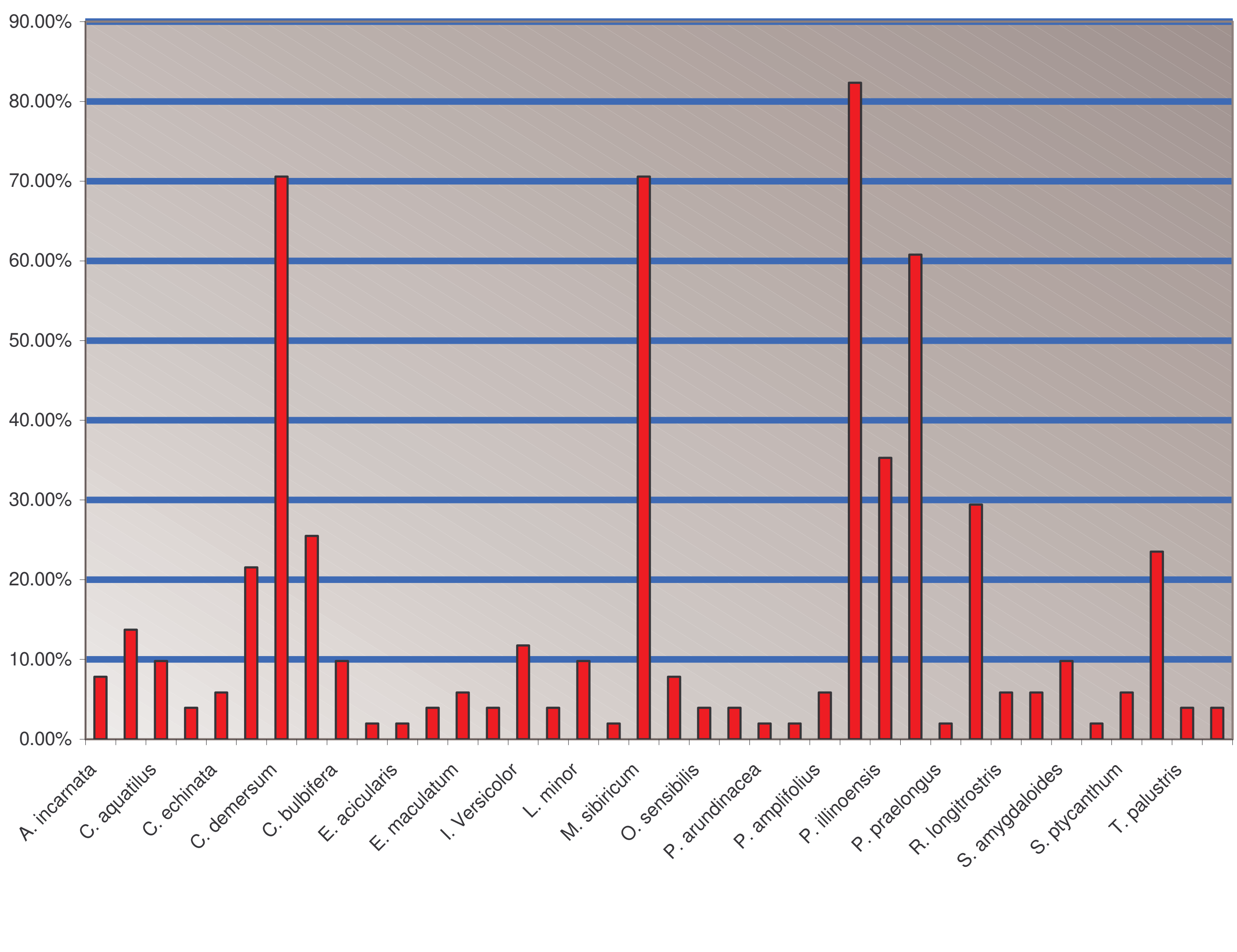
Table 4—Aquatic Plants Found in McGinnis Lake, 2006

Scientific Name	Common Name	Type
Asclepias incaranata	Swamp Milkweed	Emergent
Calamagrostis canadensis	Blue-Joint Grass	Emergent
Carex aquatilis	Water Sedge	Emergent
Carex bebbii	Bebb's Sedge	Emergent
Carex echinata	Star Sedge	Emergent
Carex hystericina	Bottlebrush Sedge	Emergent
Ceratophyllum demersum	Coontail	Submergent
Chara spp	Muskgrass	Submergent
Cicuta bulbifera	Water Hemlock	Emergent
Cicuta maculata	Spotted Water Hemlock	Emergent
Elocharis acicularis	Needle Spikerush	Emergent
Elodea canadensis	Waterweed	Submergent
Eupatorium maculatum	Spotted Joe Pye Weed	Emergent
Impatiens capensis	Jewelweed	Emergent
Iris versicolor	Blue-Flag Iris	Emergent
Juncus effusus	Common Rush	Emergent
Lemna minor	Lesser Duckweed	Free-Floating
Lysimachia quadriflora	4-Flowered Yellow Loosestrife	Emergent
Myriophyllum sibiricum	Northern Milfoil	Submergent
Najas flexilis	Bushy Pondweed	Submergent
Onoclea sensibilis	Sensitive Fern	Emergent
Pedicularis canadensis	Wood Betony	Emergent
Phalaris arundinacea	Reed Canarygrass	Emergent
Polygonum amphibium	Water Smartweed	Floating-Leaf
Potamogeton amplifolius	Large-Leaf Pondweed	Submergent
Potamogeton crispus	Curly-Leaf Pondweed	Submergent
Potamogeton illinoensis	Illnois Pondweed	Submergent
Potamogeton pectinatus	Sago Pondweed	Submergent
Potamogeton praelongus	White-Stemmed Pondweed	Submergent
Potamogeton richardsonii	Clasping-Leaf Pondweed	Submergent
Rancunculus longirostris	Water Buttercup	Emergent
Rumex orbiculatus	Great Water Dock	Emergent
Salix amygdaloides	Peach-Leaf Willow	Emergent
Scirpus validus	Soft-Stem Bulrush	Emergent
Solanum ptycanthum	Nightshade	Emergent
Spirdoela polyrhiza	Greater Duckweed	Free-Floating
Thelypteris palustris	Marsh Fern	Emergent
Typha latifolia	Narrow-Leaf Cattail	Emergent
Wolffia columbiana	Watermeal	Free-Floating

FREQUENCY OF OCCURRENCE

Potamogeton crispus was the most frequently-occurring plant in McGinnis Lake in 2006 (82.35% frequency), followed by *Ceratophyllum demersum* (70.59%), *Myriophyllum sibiricum* (70.59%), and *Potamogeton pectinatus* (60.78%). No other species reached a frequency of 50% or greater. Filamentous algae were found at 86.27% of the sample sites.

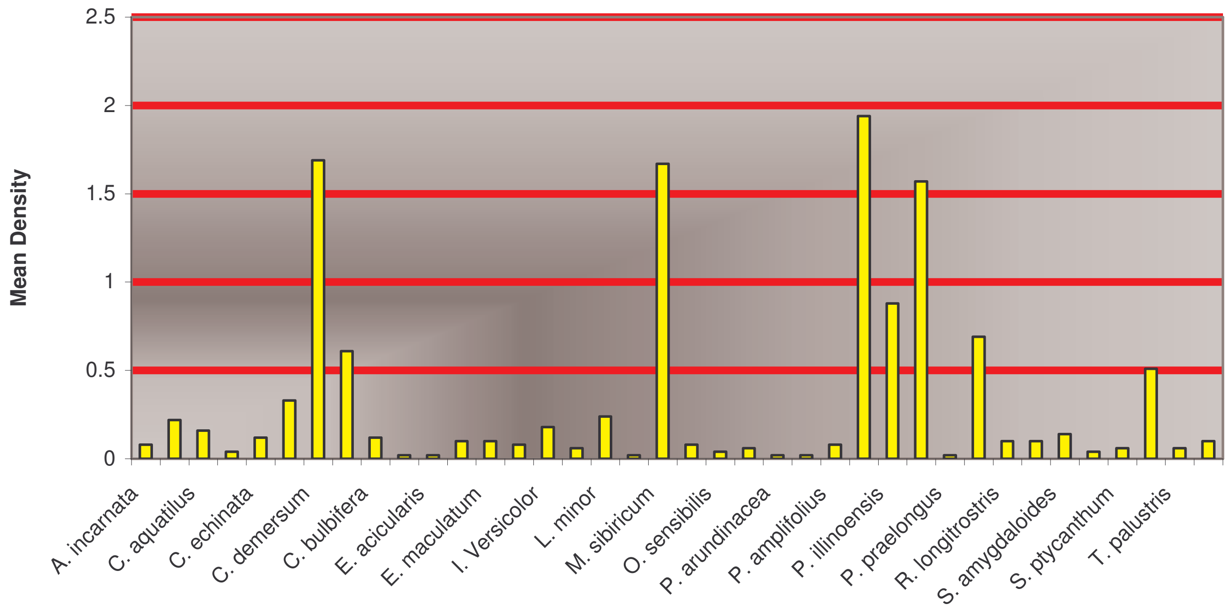
Chart 1: Occurrence Frequency



DENSITY OF OCCURRENCE

Potamogeton crispus was also the densest plant in McGinnis Lake, with a mean density of 1.94 (on a scale of 1-5). Somewhat less dense plants were *Ceratophyllum demersum* (1.69), *Myriophyllum sibiricum* (1.67) and *Potamogeton pectinatus* (1.57). No plants had over 2.0 mean density overall, i.e., no plants occurred at greater than average density overall. No plants occurred at greater than average density in Depth Zone 1 (0-1.5') either; the closest was *Potamogeton crispus* with 1.80 mean density. However, in Depth Zone 2 (1.5'-5'), *Potamogeton pectinatus* (2.27), and *Potamogeton crispus* (2.20) occurred at more than average mean density. In Depth Zone 3 (5'-10'), *Myriophyllum sibiricum, Potamogeton crispus* and *Potamogeton pectinatus* all occurred at density of 2.14, i.e., greater than average mean density. *Ceratophyllum demersum* (2.57) occurred at above average density in Depth Zone 4 (10'-20').

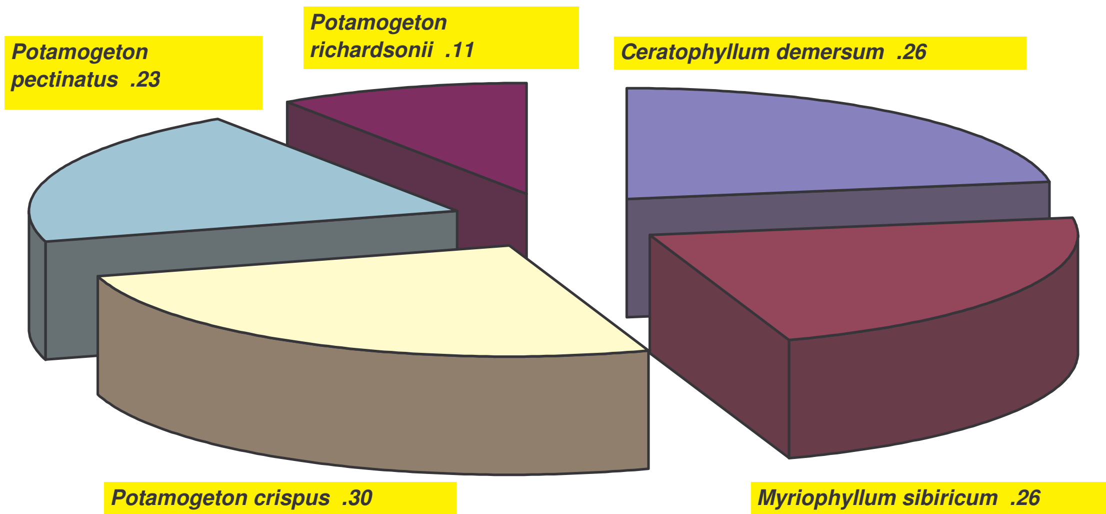
Chart 2: Mean Density



DOMINANCE

Relative frequency and relative density are combined into a dominance value that demonstrates how dominant a species is within its aquatic plant community. Based on dominance value, *Potamogeton crispus* (an invasive exotic) was the dominant aquatic plant species in McGinnis Lake during early summer. Sub-dominant were *Ceratophyllum demersum, Myriophyllum sibiricum* and *Potamogeton pectinatus*. *Phalaris arundinacea*, the other exotic found at McGinnis Lake, was not present in high frequency, high density or high dominance.

Chart 3: Dominance



Potamogeton crispus was dominant in Depth Zone 1, with *Myriophyllum sibiricum* and *Spirodela polyrhiza* tied for sub-dominance. *Potamogeton crsipus* als*o* dominated Depth Zone 2, with *Myriophyllum sibricum* sub-dominant. *Potamogeton crispus* and *Potamogeton pectinatus* tied for dominance in Depth Zone 3, with *Myriophyllum sibiricum* sub-dominant. *Ceratophyllum demersum* was dominant in Depth Zone 4; no species was sub-dominant in that depth zone.

DISTRIBUTION

Aquatic plants occurred at 100% of the sample sites in McGinnis Lake to a maximum rooting depth of 19'. 82.27% of the sites had filamentous algae.

Secchi disc readings are used to predict maximum rooting depth for plants in a lake (Dunst, 1982). Based on the summer 2004-2006 Secchi disc readings, the predicted maximum rooting depth in McGinnis Lake would be **10.2 feet.** During the 2006 aquatic plant survey, rooted plants were found to a maximum depth of **19'**, i.e., rooted plants were at a depth more to that to be expected by Dunst calculations.

The 0-1.5' depth zone (Zone 1) supported the greatest total occurrence of aquatic plant growth. There was a sharp drop to occurrence in Zone 2 (1.5'-5'), then another drop to Zone 3 (5'-10'), and a final sharp drop in total plant occurrence in Zone 4 (over 10'). The same pattern was followed with aquatic plant density.

Chart 4: Occurrence by Depth Zone

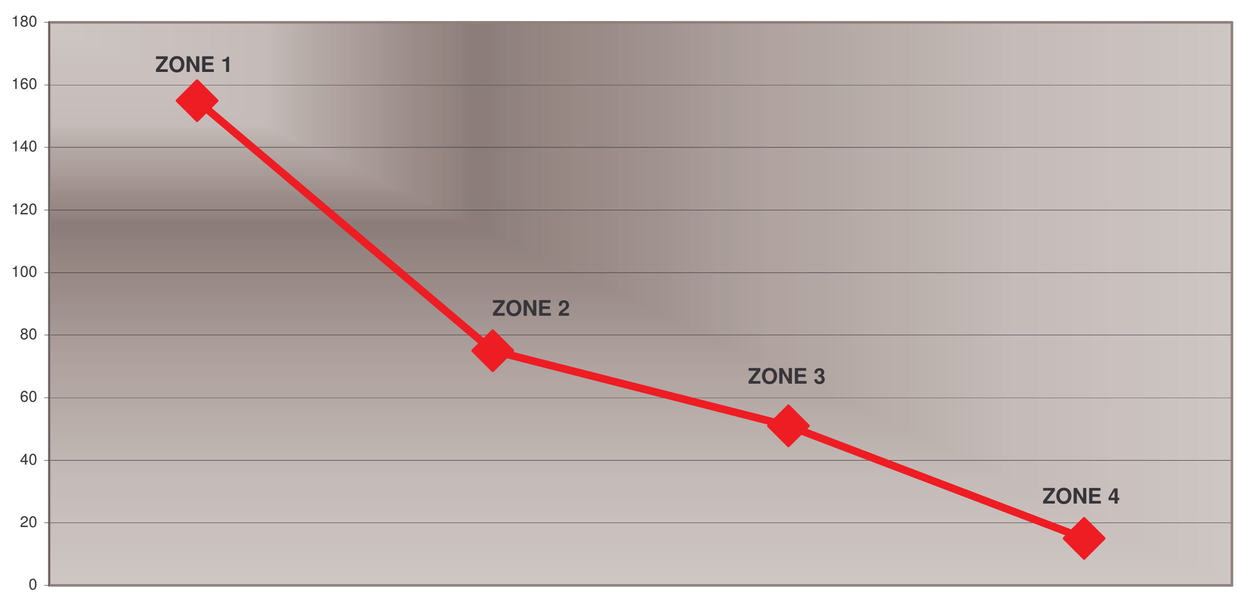
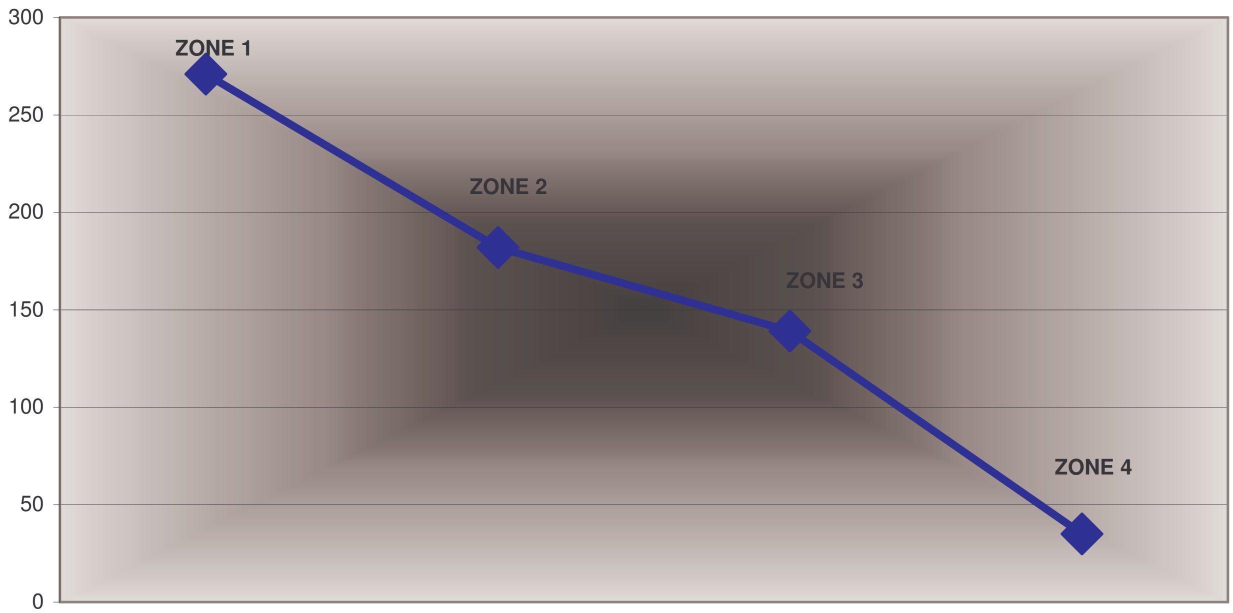


Chart 5: Zone Density Occurrence



The greatest number of species per site (species richness) was found in Zone 1 with 10.33 species richness. A sharp drop was found in Zone 2 and Zone 3, with species richness of 5.00 and 3.64 respectively. Zone 4 species richness was 2.14. Overall species richness was 5.8.

THE COMMUNITY

The Simpson's Diversity Index for McGinnis Lake was 0.92, very good species diversity. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable). This places McGinnis Lake in the upper quartile for Simpson's Diversity Index readings for both North Central Hardwood Forest and all Wisconsin lakes. The AMCI for McGinnis Lake is 56, placing it in the average range for North Central Wisconsin Lakes and all Wisconsin Lakes.

Table 5: Aquatic Macrophyte Community Index-2006

Aquatic Macrophyte Community Index for McGinnis Lake 2006		
Category	McGinnis Lake results	Value
Maximum rooting depth	19'	10
% littoral area vegetated	100%	10
%submersed plants	62%	6
% sensitive plants	14%	7
# taxa found	39 (2 exotic)	10
exotic species frequency	14%	4
Simpon's Diversity	.92	9
total		**56**

The presence of *Potamogeton crispus* is a significant factor in the future. Currently, it appears to be taking over the aquatic plant community. Its early growth and ability to spread quickly makes it a danger to the diversity and aquatic habitat of McGinnis Lake.

An Average Coefficient of Conservatism and a Floristic Quality Index calculation were performed on the field results. Technically, the Average Coefficient of Conservatism measures the community's sensitivity to disturbance, while the Floristic Quality Index measures the community's closeness to an undisturbed condition. Indirectly, they measure past and/or current disturbance to the particular community.

Previously, a value was assigned to all plants known in Wisconsin to categorize their probability of occurring in an undisturbed habitat. This value is called the plant's Coefficient of Conservatism. A score of 0 indicates a native or alien opportunistic invasive plant. Plants with a value of 1 to 3 are widespread native plants. Values of 4 to 6 describe native plants found most commonly in early successional ecosystem. Plants scoring 6 to 8 are native plants found in stable climax conditions. Finally, plants with a value of 9 or 10 are native plants found in areas of high quality and are often rare, endangered or threatened. In other words, the lower the numerical value a plant has, the more likely it is to be found in disturbed areas.

The Average Coefficient of Conservatism in McGinnis Lake in 2006 was 4.9. This puts it in the lowest quartile for Wisconsin Lakes (average 6.0) and for lakes in the North Central Hardwood Region (average 5.6). The aquatic plant community in McGinnis Lake is in the category of those very tolerant of disturbance, probably due to selection by a series of past disturbances, such as developed shorelines, boat traffic, and introduction of non-native species.

The Floristic Quality Index of the aquatic plant community in McGinnis Lake of 30.58 is above average for Wisconsin Lakes (22.2) and the North Central Hardwood Region (20.9). This suggests that the plant community in McGinnis Lake is closer to an undisturbed condition than the average lake in Wisconsin overall and in the North Central Hardwood Region. Using either scale, the aquatic plant community in McGinnis Lake has been impacted by less than average amount of disturbance.

"Disturbance" is a term that covers many disruptions to a natural community. It includes physical disturbances to plant beds such as boat traffic, plant harvesting, chemical treatments, dock and other structure placements, shoreline development and fluctuating water levels. Indirect disturbances like sedimentation, erosion, increased algal growth, and other water quality impacts will also negatively affect an aquatic plant community. Biological disturbances such as the introduction of non-native and/or invasive species (such as the Reed

Canarygrass and Curly-Leaf Pondweed found here), and destruction of plant beds by aquatic wildlife can also negatively impact an aquatic plant community. Shore development and sediment deposition can also reduce the quality of the aquatic plant community.

Only about one-third of the sample transects had an entirely native shore; two-thirds of the sites had some disturbance by humans. 60% of the sites had disturbance amounts of over 50%. Aquatic plant data was divided into two categories, disturbed and natural. Calculations were then performed on each category as if it was a separate lake in order to determine what differences there were between the community at natural shores vs. disturbed shores.

	Natural	**Disturbed**
Number of species	26	36
FQI	26.08	29.83
Average Coef. Of Cons	5.12	4.97
Simpson's Index	0.91	.92
AMCI	58	54
Filamentous algae	100%	93.94%

Using these figures, the disturbed shore community actually had a higher score for Simpson's Index, FQI and species number, but the natural shore community had a higher coefficient of Conservatism and higher Aquatic Macrophyte Community Index. The high amount of disturbance in the lake overall probably explains this variety of differentiation between natural and disturbed shore communities.

IV. DISCUSSION

Based on water clarity, chlorophyll and phosphorus data, McGinnis Lake is a mesotrophic impoundment lake with good water clarity and fair to good water quality. This trophic state should support abundant plant growth and occasional algal blooms.

Sufficient nutrients (trophic state), fair water clarity, shallow lake, soft sediments and increased shore development at McGinnis Lake favor plant growth. Despite the sometime limiting effect of sand sediments on aquatic plant growth, 89% of the lake is vegetated, suggesting that even the sand sediments in McGinnis Lake hold sufficient nutrients to maintain aquatic plant growth.

All aquatic plant control methods in McGinnis Lake have been chemical. A continued regular schedule and pattern of machine harvesting could help in removing vegetation from the lake and may help with nutrient reduction. The harvesting should also be designed to set back the growth of Curly-Leaf Pondweed. It might also help to skim off the high density of filamentous algae and floating-leaf plants, especially in the shallower areas of the lake.

Of the 39 species found in McGinnis Lake in 2006, 37 were native and 2 were exotic invasives. In the native plant category, 23 were emergent, 3 were free-floating plants, 1 was a floating-leaf rooted type, and 10 were submergent types (see Table 4). Two exotic invasives, *Phalaris arundinacea* (Reed Canarygrass) and *Potamogeton crispus* (Curly-Leaf Pondweed), were found.

Potamogeton crispus was the most frequently-occurring plant in McGinnis Lake in 2006 (82.35% frequency), followed by *Ceratophyllum demersum* (70.59%), *Myriophyllum sibiricum* (70.59%), and *Potamogeton pectinatus* (60.78%). No other species reached a frequency of 50% or greater. Filamentous algae were found at 86.27% of the sample sites.

Potamogeton crispus was also the densest plant in McGinnis Lake, with a mean density of 1.94. Somewhat less dense plants were *Ceratophyllum demersum* (1.69), *Myriophyllum sibiricum* (1.67) and *Potamogeton pectinatus* (1.57). No plants had over 2.0 mean density overall, i.e., no plants occurred at greater than average density overall. No plants occurred at greater than average density in Depth Zone 1 (0-1.5') either; the closest was *Potamogeton crispus* at 1.80 density. However, in Depth Zone 2 (1.5'-5'), *Potamogeton pectinatus* (2.27), and *Potamogeton crispus* (2.20) occurred at more than average mean density. In Depth Zone 3 (5'-10'), *Myriophyllum sibiricum, Potamogeton crispus* and *Potamogeton pectinatus* all occurred at a mean density of 2.14, i.e., greater than average density. *Ceratophyllum demersum* (2.57) occurred at above average density in Depth Zone 4 (10'-20').

Areas of the lake with natural vegetation on the shore should be preserved as they are to maintain habitat and to serve as a buffer for that area. Studies have suggested that runoff from established wooded land is substantially less than that of developed areas. There are also some areas of deep erosion on steep banks that need to be addressed to prevent tree fall (and related root ball removal from bank) and to preserve the bank. Some of the very steep slopes on the north side of the deep lobe are especially vulnerable to erosion and stormwater runoff.

The Simpson's Diversity Index for McGinnis Lake was 0.92, very good species diversity. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable). This places it in the upper quartile for Simpson's Diversity Index readings for both North Central Hardwood Forest and all Wisconsin lakes. The AMCI for McGinnis Lake is 56, placing it in the average range for North Central Wisconsin Lakes and all Wisconsin Lakes.

Some kind of native vegetation was the dominant shore cover in McGinnis Lake (total of 54.34%). However, disturbed sites, such as those with cultivated lawn, hard structure, rock/riprap and pavement, were also common, with coverage of nearly 46%. Of natural shorelines, herbaceous vegetation had the most coverage (30.67%). Some type of disturbed shoreline was found at 67% of the sites. Such a high rate of shore coverage by disturbed conditions and a high frequency of occurrence of disturbed shore offer little protection for water quality and have significant potential to negatively impact McGinnis Lake's water quality by increased runoff (including lawn fertilizers, pet waste, pesticides) and shore erosion.

V. CONCLUSIONS

Based on water clarity, chlorophyll and phosphorus data, McGinnis Lake is a mesotrophic impoundment with good water clarity and fair to good water quality. This trophic state should support abundant plant growth and occasional algal blooms. The Average Coefficient of Conservatism of the aquatic plant community in McGinnis Lake is below average for Wisconsin lakes and for lakes in the North Central Hardwood region, but the Floristic Quality Index was above average. The AMCI is in the average range for both North Central Hardwood Region and all Wisconsin lakes. Filamentous algae were over-abundant. Structurally, the aquatic plant community contains emergent plants, free-floating plants, floating-leaf rooted plants and submergent plants.

When the aquatic plant survey was performed in 2006, 100% of the littoral zone was vegetated. The potential for plant growth at all depths of the lake is present, even though a few of the lake sediments are sandy. This percent of plant cover is slightly over the recommended plant cover for a balanced fishery (50%-85%).

Potamogeton crispus was the most frequently-occurring plant in McGinnis Lake in 2006 (82.35% frequency), followed by *Ceratophyllum demersum* (70.59%), *Myriophyllum sibiricum* (70.59%), and *Potamogeton pectinatus* (60.78%). No other species reached a frequency of 50% or greater. Filamentous algae were found at 86.27% of the sample sites. *Potamogeton crispus* was also the densest plant in McGinnis Lake, with a mean density of 1.94. Somewhat less dense plants were *Ceratophyllum demersum* (1.69), *Myriophyllum sibiricum* (1.67) and *Potamogeton pectinatus* (1.57). No plants had over 2.0 mean density overall, i.e., no plants occurred at greater than average density overall.

A healthy and diverse aquatic plant community plays a vital role within the lake ecosystem. Plants help improve water quality by trapping nutrients, debris and pollutants in the water body; by absorbing and/or breaking down some pollutants; by reducing shore erosion by damping wave action and stabilizing shorelines and lake bottoms; and by tying-up nutrients that would otherwise be available for algae blooms. Aquatic plants provide valuable habitat resources for fish and wildlife, often being the base level for the multi-level food chain in the lake ecosystem, and also produce oxygen needed by aquatic animals.

Further, a healthy and diverse aquatic plant community can better resist the invasion of species (native and non-native) that might otherwise “take over” and create a lower quality aquatic plant community. A well-established and diverse plant community of natives can help check the growth of more tolerant (and less desirable) plants that would otherwise crowd out some of the more sensitive species, thus reducing diversity.

Vegetated lake bottoms support larger and more diverse invertebrate populations that in turn support larger and more diverse fish and wildlife populations (Engel, 1985). Also, a mixed stand of aquatic macrophytes (plants) supports 3 to 8 times more invertebrates and fish than do monocultural stands (Engel, 1990). A diverse plant community creates more microhabitats for the preferences of more species.

MANAGEMENT RECOMMENDATIONS

(1) Because the plant cover in the littoral zone of McGinnis Lake is over the ideal (25%-85%) coverage for balanced fishery, consideration should be given to reducing plant growth in at least some areas. A map of areas to have plants removed should be developed, then removal should occur by hand to be sure that entire plants are removed and to minimize the amount of disturbance to the settlement.

(2) Natural shoreline restoration and erosion control in some areas are needed, especially on some steep banks around the deeper lobe of the lake.

(3) A buffer area of native plants should be restored on those sites that now have traditional lawns mowed to the water's edge.

(4) Stormwater management of the impervious surfaces around the lake is essential to maintain the high quality of the lake water.

(5) Septic systems around the lake should be inspected regularly and maintained properly.

(6) No lawn chemicals should be used on properties around the lake. If they must be used, they should be used no closer than 50' to the shore.

(7) The aquatic plant management plan should be updated regularly. The plan should consider including target treatment using chemicals or target harvesting for Curly Leaf Pondweed to prevent further spread, as well as avoiding sensitive areas.

(8) The McGinnis Lake Association may want to apply for grants from the Wisconsin Department of Natural Resources to help defray the cost of aquatic plant management.

(9) No broad-scale chemical treatments of aquatic plant growth are recommended due to the undesirable side-effects of such treatments, including increased nutrients from decaying plant material and decreased dissolved oxygen and opening up more areas to invasion by EWM.

(10) Fallen trees should be left at the shoreline.

(11) McGinnis Lake should participate in the Self-Help Monitoring Program through the WDNR.

(12) McGinnis Lake residents should identify, cooperate with and participate in watershed programs that will reduce nutrient and sediment inputs.

(13) Critical habitat areas were formally determined in 2004. The lake management plan should include preserving these areas and following the recommendations of the 2005 Sensitive Area Report.

(14) The areas where there are undisturbed wooded shores should be maintained and left undisturbed.

(15) The McGinnis Lake District should make sure that its lake management plan that takes into account all inputs from both the surface and ground watersheds and addresses the concerns of the overall lake community.

(16) Cooperation with the Adams County Parks Department in keeping the boat ram in safe condition should help reduce any negative impacts caused by the heavy use of this public area.

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